CY7C1522AV18, CY7C1529AV18
CY7C1523AV18, CY7C1524AV18

72-Mbit DDR-II SIO SRAM 2-Word Burst Architecture

Features

- 72-Mbit density (8M x 8, 8M x 9, 4M x 18, 2M x 36)
- 300 MHz clock for high bandwidth
- 2-word burst for reducing address bus frequency
- Double Data Rate (DDR) interfaces (data transferred at 600 MHz) at 300 MHz
- Two input clocks (K and $\overline{K}$) for precise DDR timing
  - SRAM uses rising edges only
- Two input clocks for output data (C and $\overline{C}$) to minimize clock skew and flight time mismatches
- Echo clocks (CQ and $\overline{CQ}$) simplify data capture in high-speed systems
- Synchronous internally self-timed writes
- DDR-II operates with 1.5 cycle read latency when the DLL is enabled
- Operates similar to a DDR-I device with 1 cycle read latency in DLL off mode
- 1.8V core power supply with HSTL inputs and outputs
- Variable drive HSTL output buffers
- Expanded HSTL output voltage (1.4V–V_{DD})
- Available in 165-Ball FBGA package (15 x 17 x 1.4 mm)
- Offered in both Pb-free and non Pb-free packages
- JTAG 1149.1 compatible test access port
- Delay Lock Loop (DLL) for accurate data placement

Configurations

CY7C1522AV18 – 8M x 8
CY7C1529AV18 – 8M x 9
CY7C1523AV18 – 4M x 18
CY7C1524AV18 – 2M x 36

Functional Description

The CY7C1522AV18, CY7C1529AV18, CY7C1523AV18, and CY7C1524AV18 are 1.8V Synchronous Pipelined SRAMs, equipped with Double Data Rate Separate IO (DDR-II SIO) architecture. The DDR-II SIO consists of two separate ports: the read port and the write port to access the memory array. The read port has data outputs to support read operations and the write port has data inputs to support write operations. The DDR-II SIO has separate data inputs and data outputs to completely eliminate the need to “turn-around” the data bus required with common IO devices. Access to each port is accomplished through a common address bus. Addresses for read and write are latched on alternate rising edges of the input (K) clock. Write data is registered on the rising edges of both K and $\overline{K}$. Read data is driven on the rising edges of C and $\overline{C}$ if provided, or on the rising edge of K and $\overline{K}$ if C/$\overline{C}$ are not provided. Each address location is associated with two 8-bit words in the case of CY7C1522AV18, two 9-bit words in the case of CY7C1529AV18, two 18-bit words in the case of CY7C1523AV18, and two 36-bit words in the case of CY7C1524AV18 that burst sequentially into or out of the device.

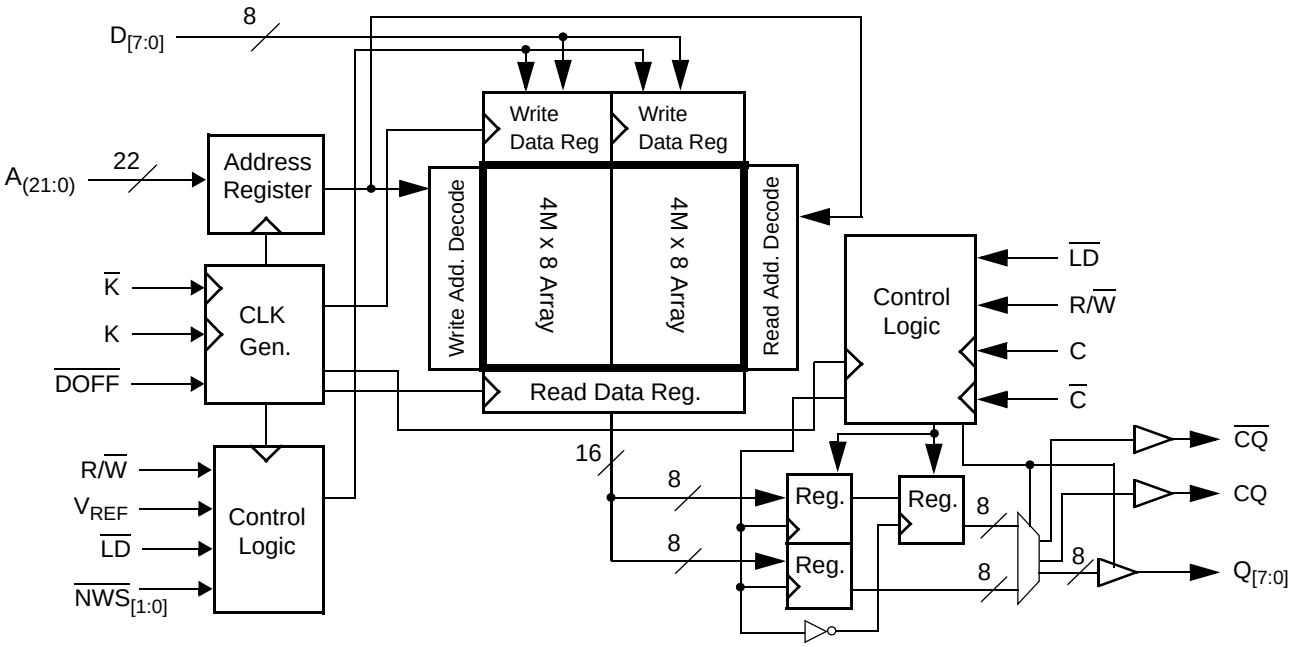
Asynchronous inputs include an output impedance matching input (ZQ). Synchronous data outputs are tightly matched to the two output echo clocks CQ/$\overline{CQ}$, eliminating the need to capture data separately from each individual DDR-II SIO SRAM in the system design. Output data clocks (C/$\overline{C}$) enable maximum system clocking and data synchronization flexibility.

All synchronous inputs pass through input registers controlled by the K or $\overline{K}$ input clocks. All data outputs pass through output registers controlled by the C or $\overline{C}$ (or K or $\overline{K}$ in a single clock domain) input clocks. Writes are conducted with on-chip synchronous self-timed write circuitry.

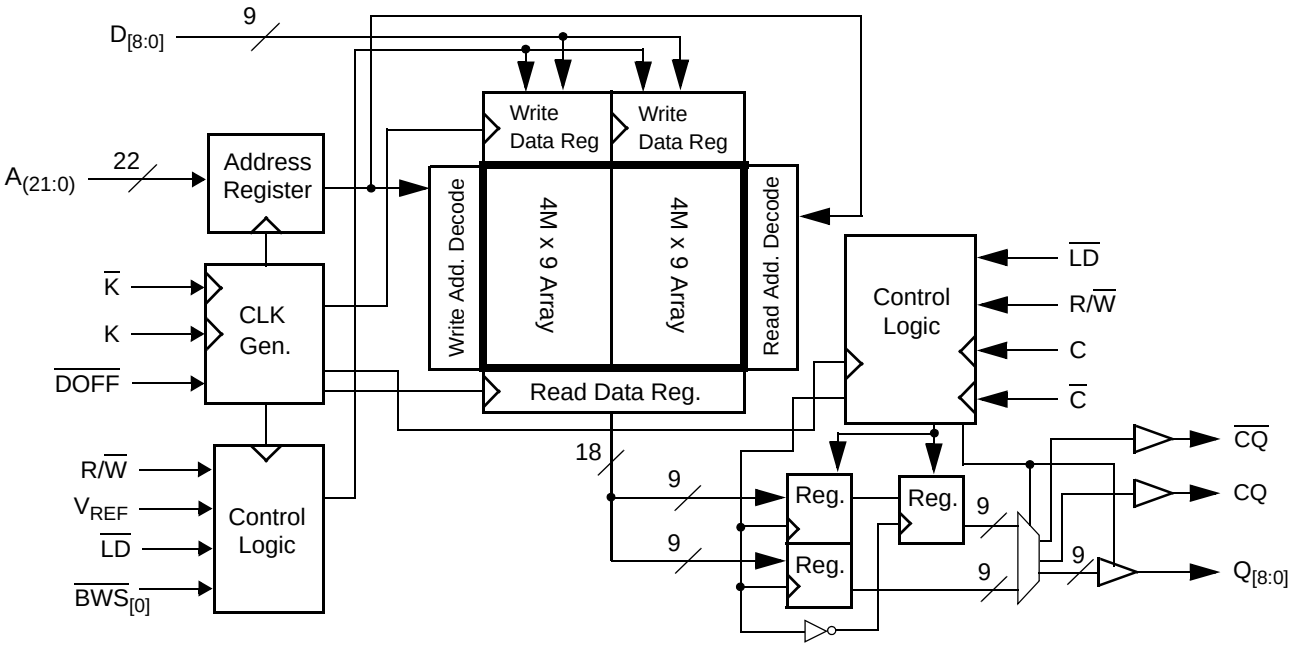
Selection Guide

Description		300 MHz	278 MHz	250 MHz	200 MHz	167 MHz	Unit
Maximum Operating Frequency		300	278	250	200	167	MHz
Maximum Operating Current	x8	900	855	800	700	650	mA
	x9	900	855	800	700	650	
	x18	950	880	800	700	650	
	x36	1080	1000	900	750	650	

Logic Block Diagram (CY7C1522AV18)



Logic Block Diagram (CY7C1529AV18)



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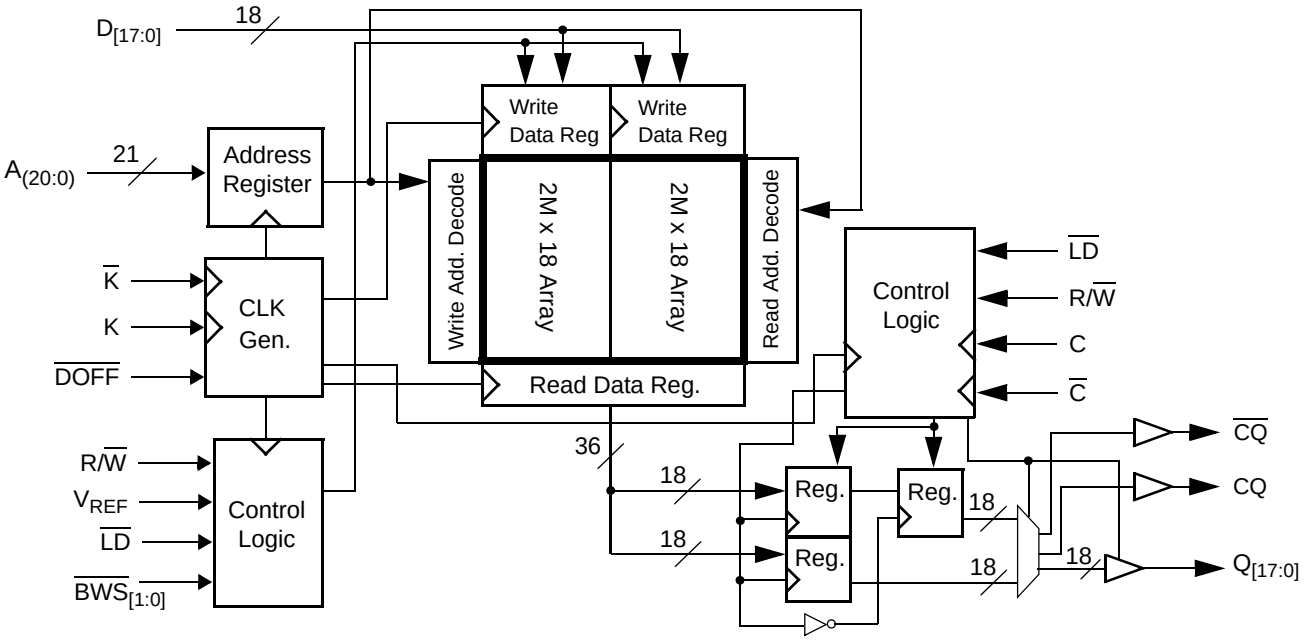
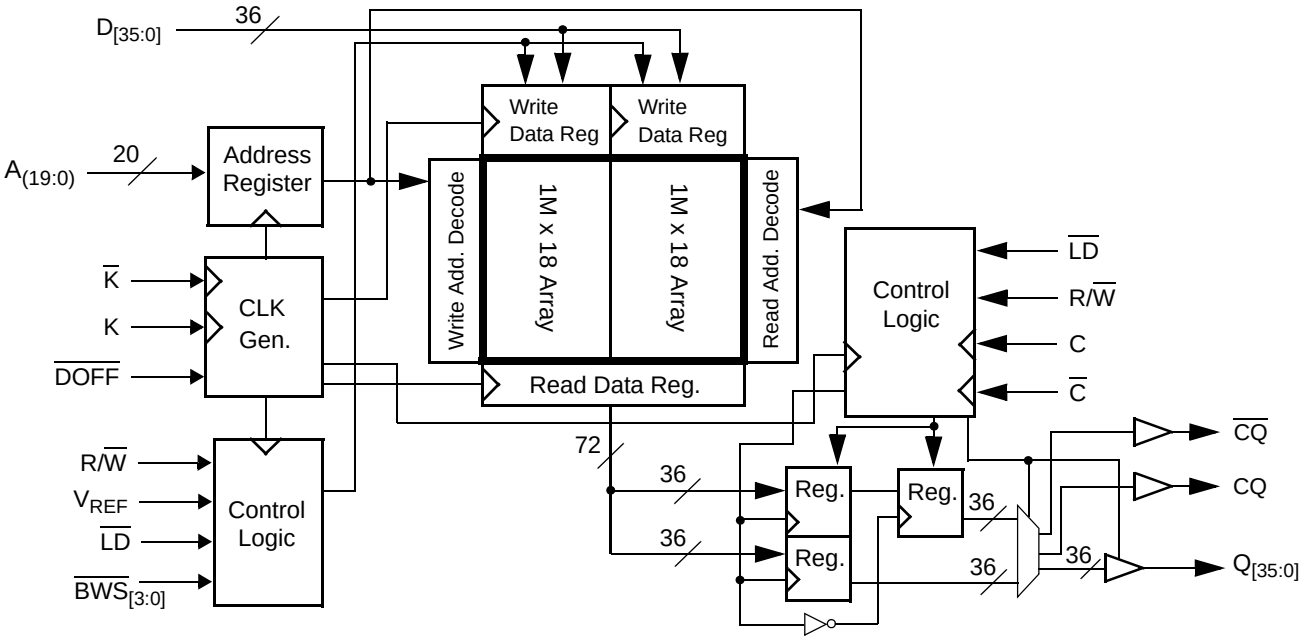
Logic Block Diagram (CY7C1523AV18)



Logic Block Diagram (CY7C1524AV18)



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Pin Configuration

The pin configuration for CY7C1522AV18, CY7C1529AV18, CY7C1523AV18, and CY7C1524AV18 follow. [1]

165-Ball FBGA (15 x 17 x 1.4 mm) Pinout

CY7C1522AV18 (8M x 8)

	1	2	3	4	5	6	7	8	9	10	11
A	$\overline{CQ}$	A	A	R/$\overline{W}$	$\overline{NWS_1}$	$\overline{K}$	NC/144M	$\overline{LD}$	A	A	CQ
B	NC	NC	NC	A	NC/288M	K	$\overline{NWS_0}$	A	NC	NC	Q3
C	NC	NC	NC	V_{SS}	A	A	A	V_{SS}	NC	NC	D3
D	NC	D4	NC	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	NC	NC	NC
E	NC	NC	Q4	V_{DDQ}	V_{SS}	V_{SS}	V_{SS}	V_{DDQ}	NC	D2	Q2
F	NC	NC	NC	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	NC	NC	NC
G	NC	D5	Q5	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	NC	NC	NC
H	$\overline{DOFF}$	V_{REF}	V_{DDQ}	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	V_{DDQ}	V_{REF}	ZQ
J	NC	NC	NC	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	NC	Q1	D1
K	NC	NC	NC	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	NC	NC	NC
L	NC	Q6	D6	V_{DDQ}	V_{SS}	V_{SS}	V_{SS}	V_{DDQ}	NC	NC	Q0
M	NC	NC	NC	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	NC	NC	D0
N	NC	D7	NC	V_{SS}	A	A	A	V_{SS}	NC	NC	NC
P	NC	NC	Q7	A	A	C	A	A	NC	NC	NC
R	TDO	TCK	A	A	A	$\overline{C}$	A	A	A	TMS	TDI

CY7C1529AV18 (8M x 9)

	1	2	3	4	5	6	7	8	9	10	11
A	$\overline{CQ}$	A	A	R/$\overline{W}$	NC	$\overline{K}$	NC/144M	$\overline{LD}$	A	A	CQ
B	NC	NC	NC	A	NC/288M	K	$\overline{BWS_0}$	A	NC	NC	Q4
C	NC	NC	NC	V_{SS}	A	A	A	V_{SS}	NC	NC	D4
D	NC	D5	NC	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	NC	NC	NC
E	NC	NC	Q5	V_{DDQ}	V_{SS}	V_{SS}	V_{SS}	V_{DDQ}	NC	D3	Q3
F	NC	NC	NC	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	NC	NC	NC
G	NC	D6	Q6	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	NC	NC	NC
H	$\overline{DOFF}$	V_{REF}	V_{DDQ}	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	V_{DDQ}	V_{REF}	ZQ
J	NC	NC	NC	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	NC	Q2	D2
K	NC	NC	NC	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	NC	NC	NC
L	NC	Q7	D7	V_{DDQ}	V_{SS}	V_{SS}	V_{SS}	V_{DDQ}	NC	NC	Q1
M	NC	NC	NC	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	NC	NC	D1
N	NC	D8	NC	V_{SS}	A	A	A	V_{SS}	NC	NC	NC
P	NC	NC	Q8	A	A	C	A	A	NC	D0	Q0
R	TDO	TCK	A	A	A	$\overline{C}$	A	A	A	TMS	TDI

Note
1. NC/144M and NC/288M are not connected to the die and can be tied to any voltage level.

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Pin Configuration (continued)

The pin configuration for CY7C1522AV18, CY7C1529AV18, CY7C1523AV18, and CY7C1524AV18 follow. [1]

165-Ball FBGA (15 x 17 x 1.4 mm) Pinout

CY7C1523AV18 (4M x 18)

	1	2	3	4	5	6	7	8	9	10	11
A	$\overline{CQ}$	NC/144M	A	R/$\overline{W}$	$\overline{BWS_1}$	$\overline{K}$	NC/288M	$\overline{LD}$	A	A	CQ
B	NC	Q9	D9	A	NC	K	$\overline{BWS_0}$	A	NC	NC	Q8
C	NC	NC	D10	V_{SS}	A	A	A	V_{SS}	NC	Q7	D8
D	NC	D11	Q10	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	NC	NC	D7
E	NC	NC	Q11	V_{DDQ}	V_{SS}	V_{SS}	V_{SS}	V_{DDQ}	NC	D6	Q6
F	NC	Q12	D12	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	NC	NC	Q5
G	NC	D13	Q13	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	NC	NC	D5
H	$\overline{DOFF}$	V_{REF}	V_{DDQ}	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	V_{DDQ}	V_{REF}	ZQ
J	NC	NC	D14	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	NC	Q4	D4
K	NC	NC	Q14	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	NC	D3	Q3
L	NC	Q15	D15	V_{DDQ}	V_{SS}	V_{SS}	V_{SS}	V_{DDQ}	NC	NC	Q2
M	NC	NC	D16	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	NC	Q1	D2
N	NC	D17	Q16	V_{SS}	A	A	A	V_{SS}	NC	NC	D1
P	NC	NC	Q17	A	A	C	A	A	NC	D0	Q0
R	TDO	TCK	A	A	A	$\overline{C}$	A	A	A	TMS	TDI

CY7C1524AV18 (2M x 36)

	1	2	3	4	5	6	7	8	9	10	11
A	$\overline{CQ}$	NC/288M	A	R/$\overline{W}$	$\overline{BWS_2}$	$\overline{K}$	$\overline{BWS_1}$	$\overline{LD}$	A	NC/144M	CQ
B	Q27	Q18	D18	A	$\overline{BWS_3}$	K	$\overline{BWS_0}$	A	D17	Q17	Q8
C	D27	Q28	D19	V_{SS}	A	A	A	V_{SS}	D16	Q7	D8
D	D28	D20	Q19	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	Q16	D15	D7
E	Q29	D29	Q20	V_{DDQ}	V_{SS}	V_{SS}	V_{SS}	V_{DDQ}	Q15	D6	Q6
F	Q30	Q21	D21	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	D14	Q14	Q5
G	D30	D22	Q22	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	Q13	D13	D5
H	$\overline{DOFF}$	V_{REF}	V_{DDQ}	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	V_{DDQ}	V_{REF}	ZQ
J	D31	Q31	D23	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	D12	Q4	D4
K	Q32	D32	Q23	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	Q12	D3	Q3
L	Q33	Q24	D24	V_{DDQ}	V_{SS}	V_{SS}	V_{SS}	V_{DDQ}	D11	Q11	Q2
M	D33	Q34	D25	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	D10	Q1	D2
N	D34	D26	Q25	V_{SS}	A	A	A	V_{SS}	Q10	D9	D1
P	Q35	D35	Q26	A	A	C	A	A	Q9	D0	Q0
R	TDO	TCK	A	A	A	$\overline{C}$	A	A	A	TMS	TDI

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Pin Definitions

Pin Name	IO	Pin Description
$D_{[x:0]}$	Input-Synchronous	**Data Input Signals.** Sampled on the rising edge of K and $\overline{K}$ clocks during valid write operations. CY7C1522AV18 - $D_{[7:0]}$ CY7C1529AV18 - $D_{[8:0]}$ CY7C1523AV18 - $D_{[17:0]}$ CY7C1524AV18 - $D_{[35:0]}$
$\overline{LD}$	Input-Synchronous	**Synchronous Load**. This input is brought LOW when a bus cycle sequence is defined. This definition includes address and read/write direction. All transactions operate on a burst of 2 data (one clock period of bus activity).
$\overline{NWS_0}$, NWS_1		**Nibble Write Select 0, 1** – **Active LOW (CY7C1522AV18 Only)**. Sampled on the rising edge of the K and K clocks during Write operations. Used to select which nibble is written into the device during the current portion of the Write operations.Nibbles not written remain unaltered. $\overline{NWS_0}$ controls $D_{[3:0]}$ and NWS_1 controls $D_{[7:4]}$. All Nibble Write Selects are sampled on the same edge as the data. Deselecting a Nibble Write Select ignores the corresponding nibble of data and it is not written into the device.
$\overline{BWS_0}$, $\overline{BWS_1}$, $\overline{BWS_2}$, $\overline{BWS_3}$	Input-Synchronous	**Byte Write Select 0, 1, 2 and 3** – **Active LOW**. Sampled on the rising edge of the K and $\overline{K}$ clocks during write operations. Used to select which byte is written into the device during the current portion of the write operations. Bytes not written remain unaltered. CY7C1529AV18 – $\overline{BWS_0}$ controls $D_{[8:0]}$ CY7C1523AV18 – $\overline{BWS_0}$ controls $D_{[8:0]}$, $\overline{BWS_1}$ controls $D_{[17:9]}$. CY7C1524AV18 – $\overline{BWS_0}$ controls $D_{[8:0]}$, $\overline{BWS_1}$ controls $D_{[17:9]}$, $\overline{BWS_2}$ controls $D_{[26:18]}$ and $\overline{BWS_3}$ controls $D_{[35:27]}$. All the Byte Write Selects are sampled on the same edge as the data. Deselecting a Byte Write Select ignores the corresponding byte of data and it is not written into the device.
A	Input-Synchronous	**Address Inputs.** Sampled on the rising edge of the K clock during active read and write operations. These address inputs are multiplexed for both read and write operations. Internally, the device is organized as 8M x 8 (2 arrays each of 4M x 8) for CY7C1522AV18, 8M x 9 (2 arrays each of 4M x 9) for CY7C1529AV18, 4M x 18 (2 arrays each of 2M x 18) for CY7C1523AV18 and 2M x 36 (2 arrays each of 1M x 36) for CY7C1524AV18. Therefore, only 22 address inputs are needed to access the entire memory array of CY7C1522AV18 and CY7C1529AV18, 21 address inputs for CY7C1523AV18 and 20 address inputs for CY7C1524AV18. These inputs are ignored when the appropriate port is deselected.
$Q_{[x:0]}$	Outputs-Synchronous	**Data Output Signals**. These pins drive out the requested data during a read operation. Valid data is driven out on the rising edge of both the C and $\overline{C}$ clocks during read operations, or K and $\overline{K}$ when in single clock mode. When the read port is deselected, $Q_{[x:0]}$ are automatically tri-stated. CY7C1522AV18 – $Q_{[7:0]}$ CY7C1529AV18 – $Q_{[8:0]}$ CY7C1523AV18 – $Q_{[17:0]}$ CY7C1524AV18 – $Q_{[35:0]}$
R/$\overline{W}$	Input-Synchronous	**Synchronous Read/Write Input**. When $\overline{LD}$ is LOW, this input designates the access type (read when R/$\overline{W}$ is HIGH, write when R/$\overline{W}$ is LOW) for the loaded address. R/$\overline{W}$ must meet the setup and hold times around the edge of K.
C	Input Clock	**Positive Input Clock for Output Data**. C is used in conjunction with $\overline{C}$ to clock out the read data from the device. C and $\overline{C}$ can be used together to deskew the flight times of various devices on the board back to the controller. See Application Example on page 9 for further details.
$\overline{C}$	Input Clock	**Negative Input Clock for Output Data**. $\overline{C}$ is used in conjunction with C to clock out the read data from the device. C and $\overline{C}$ can be used together to deskew the flight times of various devices on the board back to the controller. See Application Example on page 9 for further details.
K	Input Clock	**Positive Input Clock Input**. The rising edge of K is used to capture synchronous inputs to the device and to drive out data through $Q_{[x:0]}$ when in single clock mode. All accesses are initiated on the rising edge of K.
$\overline{K}$	Input Clock	**Negative Input Clock Input**. $\overline{K}$ is used to capture synchronous inputs being presented to the device and to drive out data through $Q_{[x:0]}$ when in single clock mode.

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Pin Definitions (continued)

Pin Name	IO	Pin Description
CQ	Echo Clock	**CQ Referenced with Respect to C**. This is a free-running clock and is synchronized to the input clock for output data (C) of the DDR-II. In the single clock mode, CQ is generated with respect to K. The timings for the echo clocks is shown in the Switching Characteristics on page 23.
$\overline{CQ}$	Echo Clock	**$\overline{CQ}$ Referenced with Respect to $\overline{C}$**. This is a free-running clock and is synchronized to the input clock for output data ($\overline{C}$) of the DDR-II. In the single clock mode, $\overline{CQ}$ is generated with respect to $\overline{K}$. The timings for the echo clocks is shown in the Switching Characteristics on page 23.
ZQ	Input	**Output Impedance Matching Input**. This input is used to tune the device outputs to the system data bus impedance. CQ, $\overline{CQ}$, and $Q_{[x:0]}$ output impedance are set to 0.2 x RQ, where RQ is a resistor connected between ZQ and ground. Alternatively, this pin can be connected directly to V_{DDQ}, which enables the minimum impedance mode. This pin cannot be connected directly to GND or left unconnected.
$\overline{DOFF}$	Input	**DLL Turn Off** – **Active LOW**. Connecting this pin to ground turns off the DLL inside the device. The timing in the DLL turned off operation differs from those listed in this data sheet. For normal operation, this pin can be connected to a pull up through a 10-Kohm or less pull up resistor. The device behaves in DDR-I mode when the DLL is turned off. In this mode, the device can be operated at a frequency of up to 167 MHz with DDR-I timing.
TDO	Output	**TDO for JTAG**.
TCK	Input	**TCK Pin for JTAG**.
TDI	Input	**TDI Pin for JTAG**.
TMS	Input	**TMS Pin for JTAG**.
NC	N/A	**Not Connected to the Die**. Can be tied to any voltage level.
NC/144M	N/A	**Not Connected to the Die**. Can be tied to any voltage level.
NC/288M	N/A	**Not Connected to the Die**. Can be tied to any voltage level.
V_{REF}	Input-Reference	**Reference Voltage Input**. Static input used to set the reference level for HSTL inputs, Outputs, and AC measurement points.
V_{DD}	Power Supply	**Power Supply Inputs to the Core of the Device**.
V_{SS}	Ground	**Ground for the Device**.
V_{DDQ}	Power Supply	**Power Supply Inputs for the Outputs of the Device**.

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Functional Overview

The CY7C1522AV18, CY7C1529AV18, CY7C1523AV18, and CY7C1524AV18 are synchronous pipelined Burst SRAMs equipped with a DDR-II Separate IO interface, which operates with a read latency of one and half cycles when DOFF pin is tied HIGH. When DOFF pin is set LOW or connected to V_{SS} the device behaves in DDR-I mode with a read latency of one clock cycle.

Accesses are initiated on the rising edge of the positive input clock (K). All synchronous input timing is referenced from the rising edge of the input clocks (K and K) and all output timing is referenced to the rising edge of the output clocks (C/C, or K/K when in single clock mode).

All synchronous data inputs ($D_{[x:0]}$) pass through input registers controlled by the rising edge of the input clocks (K and K). All synchronous data outputs ($Q_{[x:0]}$) pass through output registers controlled by the rising edge of the output clocks (C/C, or K/K when in single-clock mode).

All synchronous control (R/W, LD, $BWS_{[0:X]}$) inputs pass through input registers controlled by the rising edge of the input clock (K).

CY7C1523AV18 is described in the following sections. The same basic descriptions apply to CY7C1522AV18, CY7C1529AV18, and CY7C1524AV18.

Read Operations

The CY7C1523AV18 is organized internally as two arrays of 1M x 18. Accesses are completed in a burst of two sequential 18-bit data words. Read operations are initiated by asserting R/W HIGH and LD LOW at the rising edge of the positive input clock (K). The address presented to address inputs is stored in the read address register. Following the next K clock rise the corresponding lowest order 18-bit word of data is driven onto the $Q_{[17:0]}$ using C as the output timing reference. On the subsequent rising edge of C, the next 18-bit data word is driven onto the $Q_{[17:0]}$. The requested data is valid 0.45 ns from the rising edge of the output clock (C or C, or K and K when in single clock mode, for 200 MHz and 250 MHz device). Read accesses can be initiated on every rising edge of the positive input clock (K). This pipelines the data flow such that data is transferred out of the device on every rising edge of the output clocks, C/C (or K/K when in single clock mode).

The CY7C1523AV18 first completes the pending read transactions, when read access is deselected. Synchronous internal circuitry automatically tri-states the output following the next rising edge of the positive output clock (C).

Write Operations

Write operations are initiated by asserting R/W LOW and LD LOW at the rising edge of the positive input clock (K). The address presented to address inputs is stored in the write address register. On the following K clock rise the data presented to $D_{[17:0]}$ is latched and stored into the 18-bit write data register, provided $BWS_{[1:0]}$ are both asserted active. On the subsequent rising edge of the negative input clock (K) the information presented to $D_{[17:0]}$ is also stored into the write data register, provided $BWS_{[1:0]}$ are both asserted active. The 36 bits of data are then written into the memory array at the specified location. Write accesses can be initiated on every rising edge of the positive input clock (K). This pipelines the data flow such that 18 bits of data can be transferred into the device on every rising edge of the input clocks (K and K).

When Write access is deselected, the device ignores all inputs after the pending write operations are completed.

Byte Write Operations

Byte write operations are supported by the CY7C1523AV18. A write operation is initiated as described in the Write Operations section. The bytes that are written are determined by BWS_0 and BWS_1, which are sampled with each set of 18-bit data words. Asserting the appropriate Byte Write Select input during the data portion of a write latches the data being presented and writes it into the device. Deasserting the Byte Write Select input during the data portion of a write enables the data stored in the device for that byte to remain unaltered. This feature can be used to simplify read/modify/write operations to a byte write operation.

Single Clock Mode

The CY7C1523AV18 can be used with a single clock that controls both the input and output registers. In this mode the device recognizes only a single pair of input clocks (K and K) that control both the input and output registers. This operation is identical to the operation if the device had zero skew between the K/K and C/C clocks. All timing parameters remain the same in this mode. To use this mode of operation, tie C and C HIGH at power on. This function is a strap option and not alterable during device operation.

DDR Operation

The CY7C1523AV18 enables high-performance operation through high clock frequencies (achieved through pipelining) and double data rate mode of operation.

If a read occurs after a write cycle, address and data for the write are stored in registers. The write information must be stored because the SRAM cannot perform the last word write to the array without conflicting with the read. The data stays in this register until the next write cycle occurs. On the first write cycle after the read(s), the stored data from the earlier write is written into the SRAM array. This is called a posted write.

Depth Expansion

Depth expansion requires replicating the LD control signal for each bank. All other control signals can be common between banks as appropriate.

Programmable Impedance

An external resistor, RQ, must be connected between the ZQ pin on the SRAM and V_{SS} to enable the SRAM to adjust its output driver impedance. The value of RQ must be 5x the value of the intended line impedance driven by the SRAM. The allowable range of RQ to guarantee impedance matching with a tolerance of ±15% is between 175Ω and 350Ω, with V_{DDQ} = 1.5V. The output impedance is adjusted every 1024 cycles at power up to account for drifts in supply voltage and temperature.

Echo Clocks

Echo clocks are provided on the DDR-II to simplify data capture on high-speed systems. Two echo clocks are generated by the DDR-II. CQ is referenced with respect to C and CQ is referenced with respect to C. These are free-running clocks and are

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synchronized to the output clock of the DDR-II. In the single clock mode, CQ is generated with respect to K and CQ is generated with respect to K. The timing for the echo clocks is shown in Switching Characteristics on page 23.

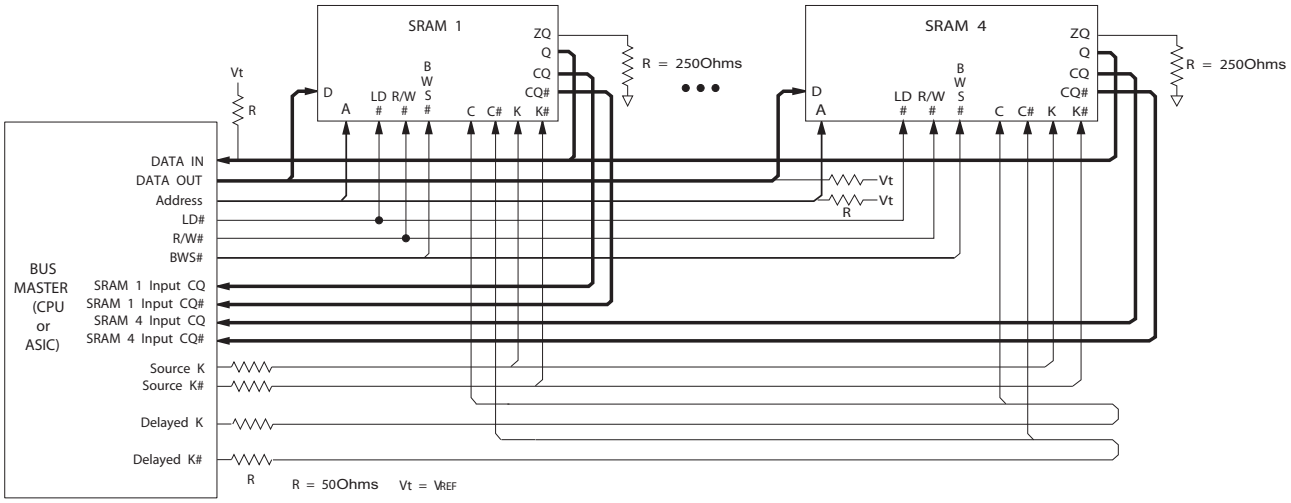
DLL

These chips use a Delay Lock Loop (DLL) that is designed to function between 120 MHz and the specified maximum clock frequency. During power up, when the DOFF is tied HIGH, the DLL is locked after 1024 cycles of stable clock. The DLL can also be reset by slowing or stopping the input clocks K and K for a minimum of 30 ns. However, it is not necessary to reset the DLL to lock it to the desired frequency. The DLL automatically locks 1024 clock cycles after a stable clock is presented. The DLL may be disabled by applying ground to the DOFF pin. When the DLL is turned off, the device behaves in DDR-I mode (with one cycle latency and a longer access time). For information refer to the application note *DLL Considerations in QDRII™/DDRII*.

Application Example

Figure 1 shows four DDR-II SIO used in an application.

Figure 1. Application Example



[+] Feedback

Truth Table

The truth table for CY7C1522AV18, CY7C1529AV18, CY7C1523AV18, and CY7C1524AV18 follows. [2, 3, 4, 5, 6, 7]

Operation	K	$\overline{LD}$	R/$\overline{W}$	DQ	DQ
Write Cycle: Load address; wait one cycle; input write data on consecutive K and $\overline{K}$ rising edges.	L-H	L	L	D(A + 0) at K(t + 1)↑	D(A + 1) at $\overline{K}$(t + 1)↑
Read Cycle: Load address; wait one and a half cycle; read data on consecutive $\overline{C}$ and C rising edges.	L-H	L	H	Q(A + 0) at $\overline{C}$(t + 1)↑	Q(A + 1) at C(t + 2)↑
NOP: No Operation	L-H	H	X	High-Z	High-Z
Standby: Clock Stopped	Stopped	X	X	Previous State	Previous State

Write Cycle Descriptions

The write cycle description table for CY7C1522AV18 and CY7C1523AV18 follows. [2, 8]

$\overline{BWS_0}$/ $\overline{NWS_0}$	$\overline{BWS_1}$/ $\overline{NWS_1}$	K	$\overline{K}$	Comments
L	L	L–H	–	During the data portion of a write sequence : CY7C1522AV18 – both nibbles ($D_{[7:0]}$) are written into the device, CY7C1523AV18 – both bytes ($D_{[17:0]}$) are written into the device.
L	L	–	L-H	During the data portion of a write sequence : CY7C1522AV18 – both nibbles ($D_{[7:0]}$) are written into the device, CY7C1523AV18 – both bytes ($D_{[17:0]}$) are written into the device.
L	H	L–H	–	During the data portion of a write sequence : CY7C1522AV18 – only the lower nibble ($D_{[3:0]}$) is written into the device, $D_{[7:4]}$ remains unaltered. CY7C1523AV18 – only the lower byte ($D_{[8:0]}$) is written into the device, $D_{[17:9]}$ remains unaltered.
L	H	–	L–H	During the data portion of a write sequence : CY7C1522AV18 – only the lower nibble ($D_{[3:0]}$) is written into the device, $D_{[7:4]}$ remains unaltered. CY7C1523AV18 – only the lower byte ($D_{[8:0]}$) is written into the device, $D_{[17:9]}$ remains unaltered.
H	L	L–H	–	During the data portion of a write sequence : CY7C1522AV18 – only the upper nibble ($D_{[7:4]}$) is written into the device, $D_{[3:0]}$ remains unaltered. CY7C1523AV18 – only the upper byte ($D_{[17:9]}$) is written into the device, $D_{[8:0]}$ remains unaltered.
H	L	–	L–H	During the data portion of a write sequence : CY7C1522AV18 – only the upper nibble ($D_{[7:4]}$) is written into the device, $D_{[3:0]}$ remains unaltered. CY7C1523AV18 – only the upper byte ($D_{[17:9]}$) is written into the device, $D_{[8:0]}$ remains unaltered.
H	H	L–H	–	No data is written into the devices during this portion of a write operation.
H	H	–	L–H	No data is written into the devices during this portion of a write operation.

Notes
2. X = “Don't Care,” H = Logic HIGH, L = Logic LOW, ↑represents rising edge.
3. Device powers up deselected with the outputs in a tri-state condition.
4. “A” represents address location latched by the devices when transaction was initiated. A + 0, A + 1 represents the internal address sequence in the burst.
5. “t” represents the cycle at which a Read/Write operation is started. t + 1, and t + 2 are the first, and second clock cycles respectively succeeding the “t” clock cycle.
6. Data inputs are registered at K and $\overline{K}$ rising edges. Data outputs are delivered on C and $\overline{C}$ rising edges, except when in single clock mode.
7. It is recommended that K = $\overline{K}$ and C = $\overline{C}$ = HIGH when clock is stopped. This is not essential, but permits most rapid restart by overcoming transmission line charging symmetrically.
8. Is based on a write cycle that was initiated in accordance with the Write Cycle Descriptions table. $\overline{NWS_0}$, $\overline{NWS_1}$, $\overline{BWS_0}$, $\overline{BWS_1}$, $\overline{BWS_2}$ and $\overline{BWS_3}$ can be altered on different portions of a write cycle, as long as the setup and hold requirements are achieved.

[+] Feedback

Write Cycle Descriptions

The write cycle description table for CY7C1529AV18 follows. [2, 8]

$\overline{BWS_0}$	K	$\overline{K}$	
L	L–H	–	During the Data portion of a write sequence, the single byte ($D_{[8:0]}$) is written into the device.
L	–	L–H	During the Data portion of a write sequence, the single byte ($D_{[8:0]}$) is written into the device.
H	L–H	–	No data is written into the device during this portion of a write operation.
H	–	L–H	No data is written into the device during this portion of a write operation.

Write Cycle Descriptions

The write cycle description table for CY7C1524AV18 follows. [2, 8]

$\overline{BWS_0}$	$\overline{BWS_1}$	$\overline{BWS_2}$	$\overline{BWS_3}$	K	$\overline{K}$	Comments
L	L	L	L	L–H	–	During the Data portion of a write sequence, all four bytes ($D_{[35:0]}$) are written into the device.
L	L	L	L	–	L–H	During the Data portion of a write sequence, all four bytes ($D_{[35:0]}$) are written into the device.
L	H	H	H	L–H	–	During the Data portion of a write sequence, only the lower byte ($D_{[8:0]}$) is written into the device. $D_{[35:9]}$ remains unaltered.
L	H	H	H	–	L–H	During the Data portion of a write sequence, only the lower byte ($D_{[8:0]}$) is written into the device. $D_{[35:9]}$ remains unaltered.
H	L	H	H	L–H	–	During the Data portion of a write sequence, only the byte ($D_{[17:9]}$) is written into the device. $D_{[8:0]}$ and $D_{[35:18]}$ remains unaltered.
H	L	H	H	–	L–H	During the Data portion of a write sequence, only the byte ($D_{[17:9]}$) is written into the device. $D_{[8:0]}$ and $D_{[35:18]}$ remains unaltered.
H	H	L	H	L–H	–	During the Data portion of a write sequence, only the byte ($D_{[26:18]}$) is written into the device. $D_{[17:0]}$ and $D_{[35:27]}$ remains unaltered.
H	H	L	H	–	L–H	During the Data portion of a write sequence, only the byte ($D_{[26:18]}$) is written into the device. $D_{[17:0]}$ and $D_{[35:27]}$ remains unaltered.
H	H	H	L	L–H	–	During the Data portion of a write sequence, only the byte ($D_{[35:27]}$) is written into the device. $D_{[26:0]}$ remains unaltered.
H	H	H	L	–	L–H	During the Data portion of a write sequence, only the byte ($D_{[35:27]}$) is written into the device. $D_{[26:0]}$ remains unaltered.
H	H	H	H	L–H	–	No data is written into the device during this portion of a write operation.
H	H	H	H	–	L–H	No data is written into the device during this portion of a write operation.

[+] Feedback

IEEE 1149.1 Serial Boundary Scan (JTAG)

These SRAMs incorporate a serial boundary scan Test Access Port (TAP) in the FBGA package. This part is fully compliant with IEEE Standard #1149.1-2001. The TAP operates using JEDEC standard 1.8V IO logic levels.

Disabling the JTAG Feature

It is possible to operate the SRAM without using the JTAG feature. To disable the TAP controller, TCK must be tied LOW (V_{SS}) to prevent clocking of the device. TDI and TMS are internally pulled up and may be unconnected. They may alternatively be connected to V_{DD} through a pull up resistor. TDO must be left unconnected. Upon power up, the device comes up in a reset state, which does not interfere with the operation of the device.

Test Access Port—Test Clock

The test clock is used only with the TAP controller. All inputs are captured on the rising edge of TCK. All outputs are driven from the falling edge of TCK.

Test Mode Select (TMS)

The TMS input is used to give commands to the TAP controller and is sampled on the rising edge of TCK. This pin may be left unconnected if the TAP is not used. The pin is pulled up internally, resulting in a logic HIGH level.

Test Data-In (TDI)

The TDI pin is used to serially input information into the registers and can be connected to the input of any of the registers. The register between TDI and TDO is chosen by the instruction that is loaded into the TAP instruction register. For information on loading the instruction register, see the TAP Controller State Diagram on page 14. TDI is internally pulled up and can be unconnected if the TAP is unused in an application. TDI is connected to the most significant bit (MSB) on any register.

Test Data-Out (TDO)

The TDO output pin is used to serially clock data out from the registers. The output is active, depending upon the current state of the TAP state machine (see Instruction Codes on page 17). The output changes on the falling edge of TCK. TDO is connected to the least significant bit (LSB) of any register.

Performing a TAP Reset

A Reset is performed by forcing TMS HIGH (V_{DD}) for five rising edges of TCK. This Reset does not affect the operation of the SRAM and can be performed while the SRAM is operating. At power up, the TAP is reset internally to ensure that TDO comes up in a high-Z state.

TAP Registers

Registers are connected between the TDI and TDO pins to scan the data in and out of the SRAM test circuitry. Only one register can be selected at a time through the instruction registers. Data is serially loaded into the TDI pin on the rising edge of TCK. Data is output on the TDO pin on the falling edge of TCK.

Instruction Register

Three-bit instructions can be serially loaded into the instruction register. This register is loaded when it is placed between the TDI and TDO pins, as shown in TAP Controller Block Diagram on page 15. Upon power up, the instruction register is loaded with the IDCODE instruction. It is also loaded with the IDCODE instruction if the controller is placed in a reset state, as described in the previous section.

When the TAP controller is in the Capture-IR state, the two least significant bits are loaded with a binary “01” pattern to allow for fault isolation of the board level serial test path.

Bypass Register

To save time when serially shifting data through registers, it is sometimes advantageous to skip certain chips. The bypass register is a single-bit register that can be placed between TDI and TDO pins. This enables shifting of data through the SRAM with minimal delay. The bypass register is set LOW (V_{SS}) when the BYPASS instruction is executed.

Boundary Scan Register

The boundary scan register is connected to all of the input and output pins on the SRAM. Several No Connect (NC) pins are also included in the scan register to reserve pins for higher density devices.

The boundary scan register is loaded with the contents of the RAM input and output ring when the TAP controller is in the Capture-DR state and is then placed between the TDI and TDO pins when the controller is moved to the Shift-DR state. The EXTEST, SAMPLE/PRELOAD, and SAMPLE Z instructions can be used to capture the contents of the input and output ring.

The Boundary Scan Order on page 18 shows the order in which the bits are connected. Each bit corresponds to one of the bumps on the SRAM package. The MSB of the register is connected to TDI, and the LSB is connected to TDO.

Identification (ID) Register

The ID register is loaded with a vendor-specific, 32-bit code during the Capture-DR state when the IDCODE command is loaded in the instruction register. The IDCODE is hardwired into the SRAM and can be shifted out when the TAP controller is in the Shift-DR state. The ID register has a vendor code and other information described in Identification Register Definitions on page 17.

TAP Instruction Set

Eight different instructions are possible with the three-bit instruction register. All combinations are listed in Instruction Codes on page 17. Three of these instructions are listed as RESERVED and must not be used. The other five instructions are described in this section in detail.

Instructions are loaded into the TAP controller during the Shift-IR state when the instruction register is placed between TDI and TDO. During this state, instructions are shifted through the instruction register through the TDI and TDO pins. To execute the instruction after it is shifted in, the TAP controller must be moved into the Update-IR state.

[+] Feedback

IDCODE

The IDCODE instruction loads a vendor-specific, 32-bit code into the instruction register. It also places the instruction register between the TDI and TDO pins and shifts the IDCODE out of the device when the TAP controller enters the Shift-DR state. The IDCODE instruction is loaded into the instruction register at power up or whenever the TAP controller is supplied a Test-Logic-Reset state.

SAMPLE Z

The SAMPLE Z instruction connects the boundary scan register between the TDI and TDO pins when the TAP controller is in a Shift-DR state. The SAMPLE Z command puts the output bus into a High-Z state until the next command is supplied during the Update IR state.

SAMPLE/PRELOAD

SAMPLE/PRELOAD is a 1149.1 mandatory instruction. When the SAMPLE/PRELOAD instructions are loaded into the instruction register and the TAP controller is in the Capture-DR state, a snapshot of data on the input and output pins is captured in the boundary scan register.

The user must be aware that the TAP controller clock can only operate at a frequency up to 20 MHz, while the SRAM clock operates more than an order of magnitude faster. Because there is a large difference in the clock frequencies, it is possible that during the Capture-DR state, an input or output undergoes a transition. The TAP may then try to capture a signal while in transition (metastable state). This does not harm the device, but there is no guarantee as to the value that is captured. Repeatable results may not be possible.

To guarantee that the boundary scan register captures the correct value of a signal, the SRAM signal must be stabilized long enough to meet the TAP controller's capture setup plus hold times (t_{CS} and t_{CH}). The SRAM clock input might not be captured correctly if there is no way in a design to stop (or slow) the clock during a SAMPLE/PRELOAD instruction. If this is an issue, it is still possible to capture all other signals and simply ignore the value of the CK and $\overline{CK}$ captured in the boundary scan register.

After the data is captured, it is possible to shift out the data by putting the TAP into the Shift-DR state. This places the boundary scan register between the TDI and TDO pins.

PRELOAD places an initial data pattern at the latched parallel outputs of the boundary scan register cells before the selection of another boundary scan test operation.

The shifting of data for the SAMPLE and PRELOAD phases can occur concurrently when required, that is, while the data captured is shifted out, the preloaded data can be shifted in.

BYPASS

When the BYPASS instruction is loaded in the instruction register and the TAP is placed in a Shift-DR state, the bypass register is placed between the TDI and TDO pins. The advantage of the BYPASS instruction is that it shortens the boundary scan path when multiple devices are connected together on a board.

EXTEST

The EXTEST instruction drives the preloaded data out through the system output pins. This instruction also connects the boundary scan register for serial access between the TDI and TDO in the Shift-DR controller state.

EXTEST OUTPUT BUS TRI-STATE

IEEE Standard 1149.1 mandates that the TAP controller be able to put the output bus into a tri-state mode.

The boundary scan register has a special bit located at bit #108. When this scan cell, called the “extest output bus tri-state,” is latched into the preload register during the Update-DR state in the TAP controller, it directly controls the state of the output (Q-bus) pins, when the EXTEST is entered as the current instruction. When HIGH, it enables the output buffers to drive the output bus. When LOW, this bit places the output bus into a High-Z condition.

This bit can be set by entering the SAMPLE/PRELOAD or EXTEST command, and then shifting the desired bit into that cell, during the Shift-DR state. During Update-DR, the value loaded into that shift-register cell latches into the preload register. When the EXTEST instruction is entered, this bit directly controls the output Q-bus pins. Note that this bit is pre-set LOW to enable the output when the device is powered up, and also when the TAP controller is in the Test-Logic-Reset state.

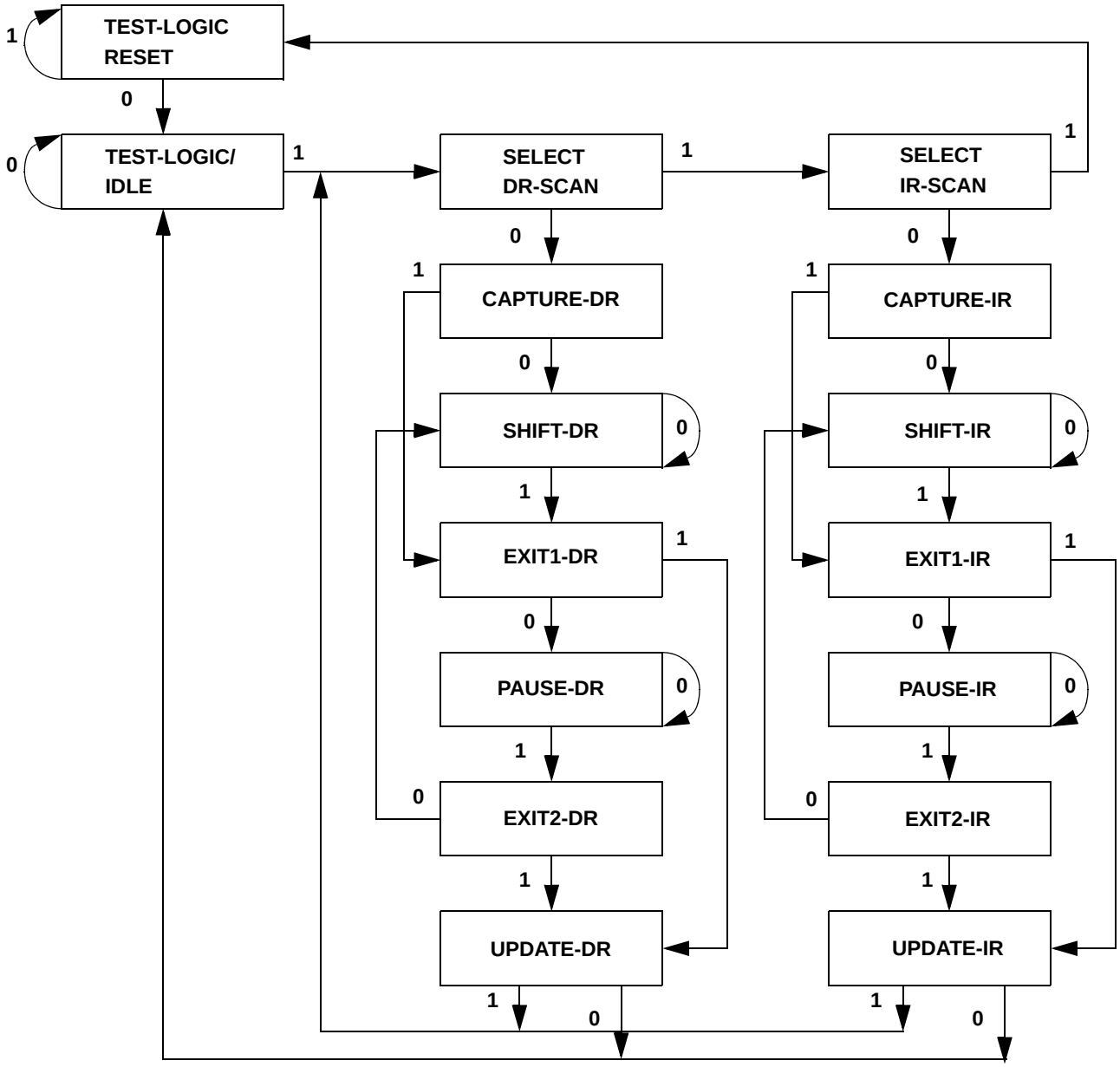
Reserved

These instructions are not implemented but are reserved for future use. Do not use these instructions.

[+] Feedback

TAP Controller State Diagram

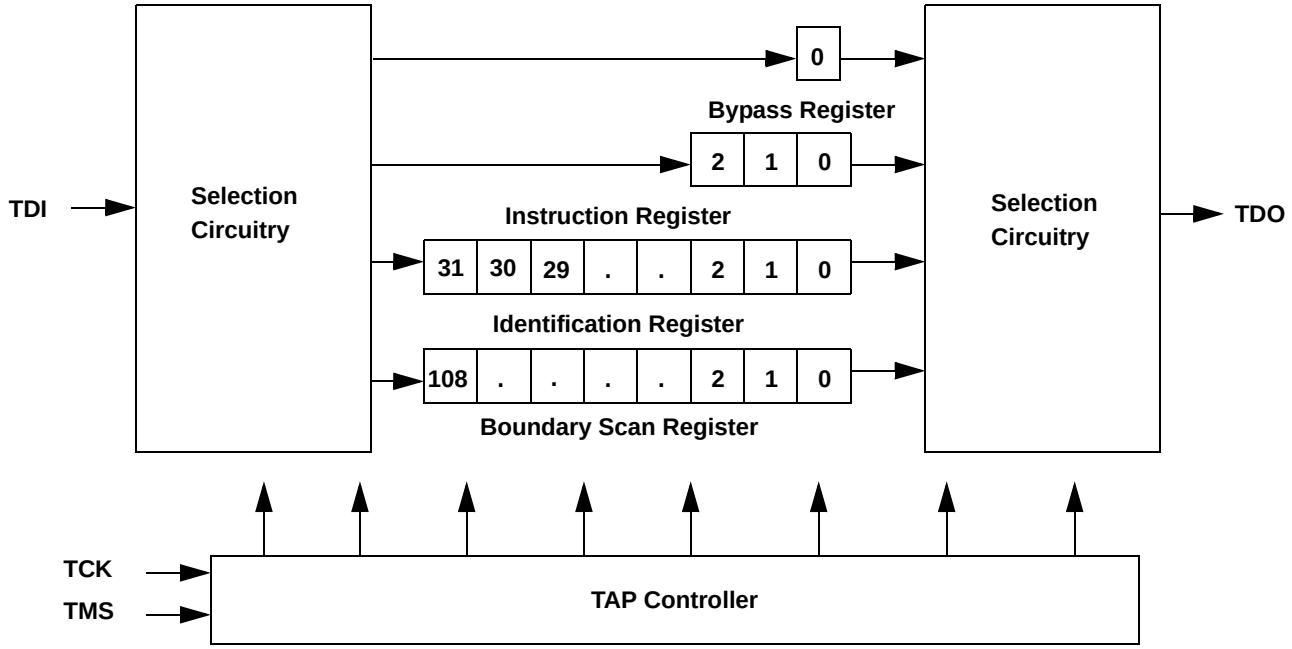
The state diagram for the TAP controller follows. [9]



Note
9. The 0/1 next to each state represents the value at TMS at the rising edge of TCK.

[+] Feedback

TAP Controller Block Diagram



TAP Electrical Characteristics

Over the Operating Range [10, 11, 12]

Parameter	Description	Test Conditions	Min	Max	Unit
V_{OH1}	Output HIGH Voltage	I_{OH} = –2.0 mA	1.4		V
V_{OH2}	Output HIGH Voltage	I_{OH} = –100 µA	1.6		V
V_{OL1}	Output LOW Voltage	I_{OL} = 2.0 mA		0.4	V
V_{OL2}	Output LOW Voltage	I_{OL} = 100 µA		0.2	V
V_{IH}	Input HIGH Voltage		$0.65V_{DD}$	V_{DD} + 0.3	V
V_{IL}	Input LOW Voltage		–0.3	$0.35V_{DD}$	V
I_X	Input and Output Load Current	$GND \le V_I \le V_{DD}$	–5	5	µA

Notes
10. These characteristics pertain to the TAP inputs (TMS, TCK, TDI and TDO). Parallel load levels are specified in the Electrical Characteristics table.
11. Overshoot: $V_{IH}(AC) < V_{DDQ} + 0.85V$ (Pulse width less than $t_{CYC}/2$), Undershoot: $V_{IL}(AC) > -1.5V$ (Pulse width less than $t_{CYC}/2$).
12. All Voltage referenced to Ground.

[+] Feedback

TAP AC Switching Characteristics

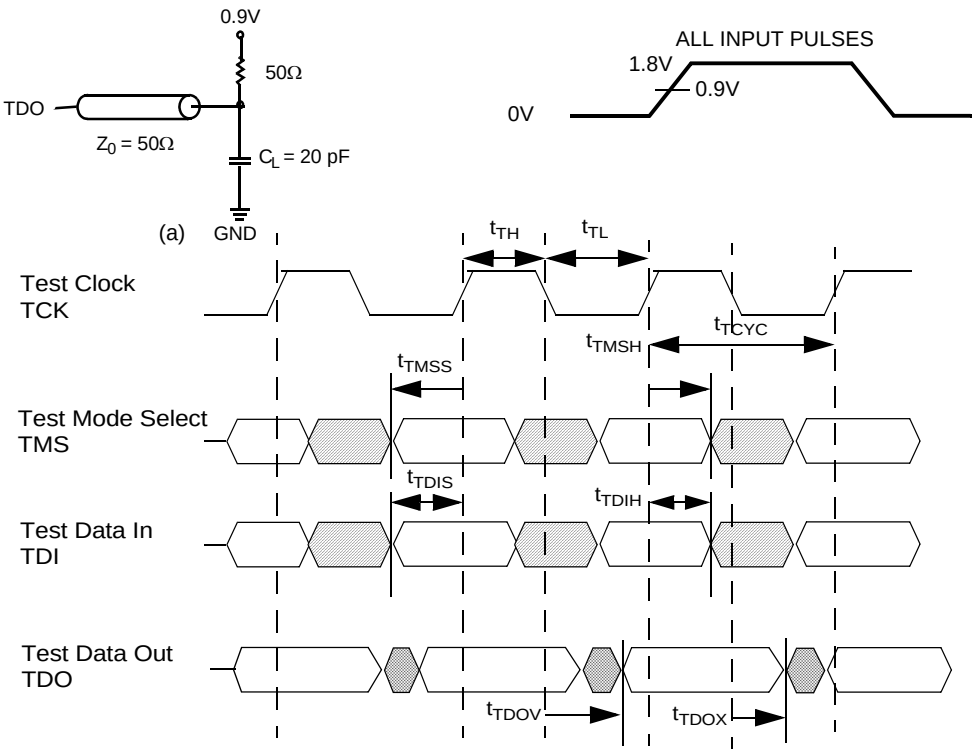
Over the Operating Range [13, 14]

Parameter	Description	Min	Max	Unit
t_{TCYC}	TCK Clock Cycle Time	50		ns
t_{TF}	TCK Clock Frequency		20	MHz
t_{TH}	TCK Clock HIGH	20		ns
t_{TL}	TCK Clock LOW	20		ns
Setup Times				
t_{TMSS}	TMS Setup to TCK Clock Rise	5		ns
t_{TDIS}	TDI Setup to TCK Clock Rise	5		ns
t_{CS}	Capture Setup to TCK Rise	5		ns
Hold Times				
t_{TMSH}	TMS Hold after TCK Clock Rise	5		ns
t_{TDIH}	TDI Hold after Clock Rise	5		ns
t_{CH}	Capture Hold after Clock Rise	5		ns
Output Times				
t_{TDOV}	TCK Clock LOW to TDO Valid		10	ns
t_{TDOX}	TCK Clock LOW to TDO Invalid	0		ns

TAP Timing and Test Conditions

Figure 2 shows the TAP timing and test conditions. [14]

Figure 2. TAP Timing and Test Conditions



Notes

13. t_{CS} and t_{CH} refer to the setup and hold time requirements of latching data from the boundary scan register.
14. Test conditions are specified using the load in TAP AC Test Conditions. t_R/t_F = 1 ns.

[+] Feedback

Identification Register Definitions

Instruction Field	Value				Description
	CY7C1522AV18	CY7C1529AV18	CY7C1523AV18	CY7C1524AV18	
Revision Number (31:29)	001	001	001	001	Version number.
Cypress Device ID (28:12)	11010100010000100	11010100010001100	11010100010010100	11010100010100100	Defines the type of SRAM.
Cypress JEDEC ID (11:1)	00000110100	00000110100	00000110100	00000110100	Allows unique identification of SRAM vendor.
ID Register Presence (0)	1	1	1	1	Indicates the presence of an ID register.

Scan Register Sizes

Register Name	Bit Size
Instruction	3
Bypass	1
ID	32
Boundary Scan	109

Instruction Codes

Instruction	Code	Description
EXTEST	000	Captures the input and output ring contents.
IDCODE	001	Loads the ID register with the vendor ID code and places the register between TDI and TDO. This operation does not affect SRAM operation.
SAMPLE Z	010	Captures the input and output contents. Places the boundary scan register between TDI and TDO. Forces all SRAM output drivers to a High-Z state.
RESERVED	011	Do Not Use: This instruction is reserved for future use.
SAMPLE/PRELOAD	100	Captures the input and output ring contents. Places the boundary scan register between TDI and TDO. Does not affect the SRAM operation.
RESERVED	101	Do Not Use: This instruction is reserved for future use.
RESERVED	110	Do Not Use: This instruction is reserved for future use.
BYPASS	111	Places the bypass register between TDI and TDO. This operation does not affect SRAM operation.

Boundary Scan Order

Bit #	Bump ID	Bit #	Bump ID	Bit #	Bump ID	Bit #	Bump ID
0	6R	28	10G	56	6A	84	1J
1	6P	29	9G	57	5B	85	2J
2	6N	30	11F	58	5A	86	3K
3	7P	31	11G	59	4A	87	3J
4	7N	32	9F	60	5C	88	2K
5	7R	33	10F	61	4B	89	1K
6	8R	34	11E	62	3A	90	2L
7	8P	35	10E	63	2A	91	3L
8	9R	36	10D	64	1A	92	1M
9	11P	37	9E	65	2B	93	1L
10	10P	38	10C	66	3B	94	3N
11	10N	39	11D	67	1C	95	3M
12	9P	40	9C	68	1B	96	1N
13	10M	41	9D	69	3D	97	2M
14	11N	42	11B	70	3C	98	3P
15	9M	43	11C	71	1D	99	2N
16	9N	44	9B	72	2C	100	2P
17	11L	45	10B	73	3E	101	1P
18	11M	46	11A	74	2D	102	3R
19	9L	47	10A	75	2E	103	4R
20	10L	48	9A	76	1E	104	4P
21	11K	49	8B	77	2F	105	5P
22	10K	50	7C	78	3F	106	5N
23	9J	51	6C	79	1G	107	5R
24	9K	52	8A	80	1F	108	Internal
25	10J	53	7A	81	3G		
26	11J	54	7B	82	2G		
27	11H	55	6B	83	1H		

[+] Feedback

Power Up Sequence in DDR-II SRAM

DDR-II SRAMs must be powered up and initialized in a predefined manner to prevent undefined operations. During Power Up, when the $\overline{DOFF}$ is tied HIGH, the DLL gets locked after 1024 cycles of stable clock.

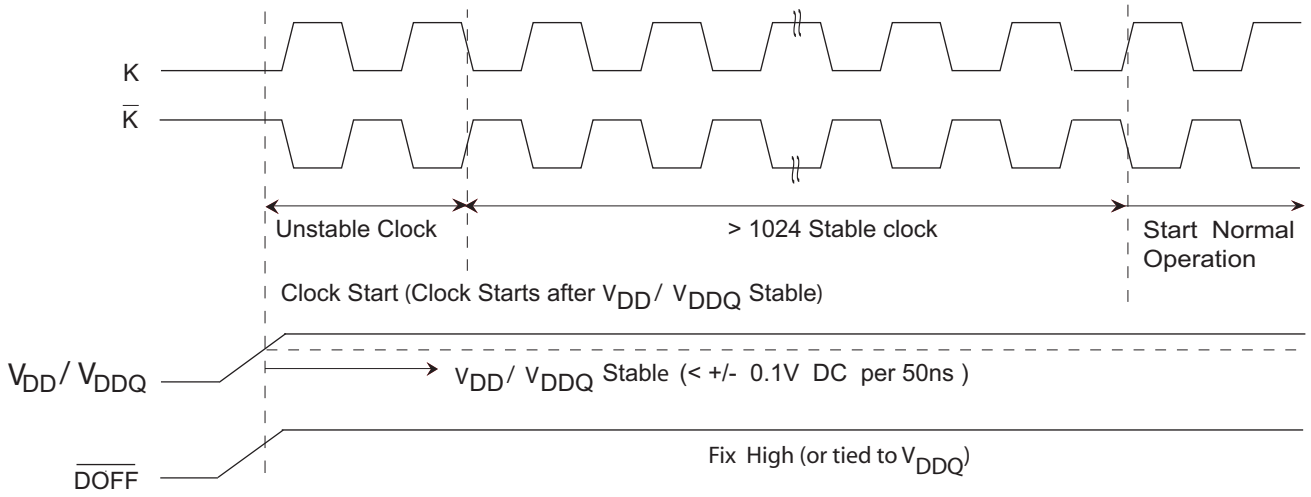
Power Up Sequence

- Apply power and drive $\overline{DOFF}$ LOW (All other inputs are HIGH or LOW)
  - Apply V_{DD} before V_{DDQ}
  - Apply V_{DDQ} before V_{REF} or at the same time as V_{REF}
- After the power and clock (K, $\overline{K}$) are stable take $\overline{DOFF}$ HIGH
- The additional 1024 cycles of clocks are required for the DLL to lock.

DLL Constraints

- DLL uses K clock as its synchronizing input. The input must have low phase jitter, which is specified as $t_{KC\ Var}$.
- The DLL functions at frequencies down to 120 MHz.
- If the input clock is unstable and the DLL is enabled, then the DLL may lock onto an incorrect frequency, causing unstable SRAM behavior. To avoid DLL locking provide 1024 cycles stable clock to relock to the desired clock frequency.

Power Up Waveforms



[+] Feedback

Maximum Ratings

Exceeding maximum ratings may impair the useful life of the device. These user guidelines are not tested.

Storage Temperature ..... –65°C to +150°C

Ambient Temperature with Power Applied.... –10°C to +85°C

Supply Voltage on V_{DD} Relative to GND ..... –0.5V to +2.9V

Supply Voltage on V_{DDQ} Relative to GND ..... –0.5V to +V_{DD}

DC Applied to Outputs in High-Z ..... –0.5V to V_{DDQ} + 0.3V

DC Input Voltage [11] ..... –0.5V to V_{DD} + 0.3V

Current into Outputs (LOW) ..... 20 mA

Static Discharge Voltage (MIL-STD-883, M. 3015).. > 2001V

Latch-up Current ..... > 200 mA

Operating Range

Range	Ambient Temperature (T_A)	V_{DD} [15]	V_{DDQ} [15]
Commercial	0°C to +70°C	1.8 ± 0.1V	1.4V to V_{DD}
Industrial	–40°C to +85°C		

Electrical Characteristics

DC Electrical Characteristics

Over the Operating Range [12]

Parameter	Description	Test Conditions			Min	Typ	Max	Unit
V_{DD}	Power Supply Voltage				1.7	1.8	1.9	V
V_{DDQ}	IO Supply Voltage				1.4	1.5	V_{DD}	V
V_{OH}	Output HIGH Voltage	Note 16			$V_{DDQ}/2 – 0.12$		$V_{DDQ}/2 + 0.12$	V
V_{OL}	Output LOW Voltage	Note 17			$V_{DDQ}/2 – 0.12$		$V_{DDQ}/2 + 0.12$	V
$V_{OH(LOW)}$	Output HIGH Voltage	I_{OH} = –0.1 mA, Nominal Impedance			$V_{DDQ} – 0.2$		V_{DDQ}	V
$V_{OL(LOW)}$	Output LOW Voltage	I_{OL} = 0.1 mA, Nominal Impedance			V_{SS}		0.2	V
V_{IH}	Input HIGH Voltage				$V_{REF} + 0.1$		$V_{DDQ} + 0.3$	V
V_{IL}	Input LOW Voltage				–0.3		$V_{REF} – 0.1$	V
I_X	Input Leakage Current	$GND \le V_I \le V_{DDQ}$			–5		5	µA
I_{OZ}	Output Leakage Current	$GND \le V_I \le V_{DDQ}$, Output Disabled			–5		5	µA
V_{REF}	Input Reference Voltage [18]	Typical Value = 0.75V			0.68	0.75	0.95	V
I_{DD}	V_{DD} Operating Supply	V_{DD} = Max, I_{OUT} = 0 mA, $f = f_{MAX} = 1/t_{CYC}$	300MHz	(x8)			900	mA
				(x9)			900	
				(x18)			950	
				(x36)			1080	
			278MHz	(x8)			855	mA
				(x9)			855	
				(x18)			880	
				(x36)			1000	
			250MHz	(x8)			800	mA
				(x9)			800	
				(x18)			800	
				(x36)			900	

Notes

15. Power up: assumes a linear ramp from 0V to V_{DD}(min) within 200 ms. During this time $V_{IH} < V_{DD}$ and $V_{DDQ} \le V_{DD}$.
16. Outputs are impedance controlled. $I_{OH} = –(V_{DDQ}/2)/(RQ/5)$ for values of $175\Omega \le RQ \le 350\Omega$.
17. Outputs are impedance controlled. $I_{OL} = (V_{DDQ}/2)/(RQ/5)$ for values of $175\Omega \le RQ \le 350\Omega$.
18. V_{REF}(min) = 0.68V or 0.46V_{DDQ}, whichever is larger, V_{REF}(max) = 0.95V or 0.54V_{DDQ}, whichever is smaller.

Electrical Characteristics (continued)

DC Electrical Characteristics

Over the Operating Range [12]

Parameter	Description	Test Conditions			Min	Typ	Max	Unit
I_{DD}	V_{DD} Operating Supply	V_{DD} = Max, I_{OUT} = 0 mA, f = f_{MAX} = $1/t_{CYC}$	200MHz	(x8)			700	mA
				(x9)			700	
				(x18)			700	
				(x36)			750	
			167MHz	(x8)			650	mA
				(x9)			650	
				(x18)			650	
				(x36)			650	
I_{SB1}	Automatic Power down Current	Max V_{DD}, Both Ports Deselected, $V_{IN} \geq V_{IH}$ or $V_{IN} \leq V_{IL}$ f = f_{MAX} = $1/t_{CYC}$, Inputs Static	300MHz	(x8)			400	mA
				(x9)			400	
				(x18)			400	
				(x36)			400	
			278MHz	(x8)			390	mA
				(x9)			390	
				(x18)			390	
				(x36)			390	
			250MHz	(x8)			380	mA
				(x9)			380	
				(x18)			380	
				(x36)			380	
			200MHz	(x8)			360	mA
				(x9)			360	
				(x18)			360	
				(x36)			360	
			167MHz	(x8)			340	mA
				(x9)			340	
				(x18)			340	
				(x36)			340	

AC Electrical Characteristics

Over the Operating Range [11]

Parameter	Description	Test Conditions	Min	Typ	Max	Unit
V_{IH}	Input HIGH Voltage		V_{REF} + 0.2	–	–	V
V_{IL}	Input LOW Voltage		–	–	V_{REF} – 0.2	V

[+] Feedback

Capacitance

Tested initially and after any design or process change that may affect these parameters.

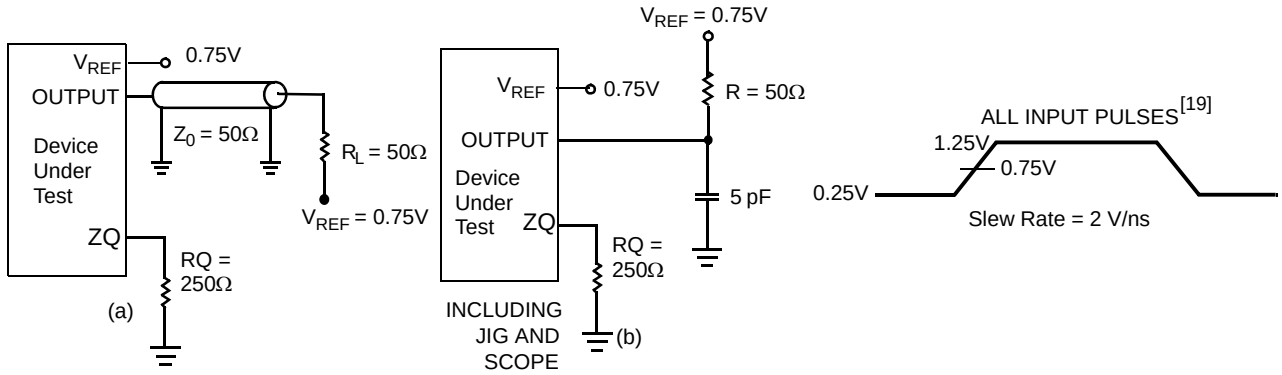
Parameter	Description	Test Conditions	Max	Unit
C_{IN}	Input Capacitance	T_A = 25°C, f = 1 MHz, V_{DD} = 1.8V, V_{DDQ} = 1.5V	5.5	pF
C_{CLK}	Clock Input Capacitance		8.5	pF
C_O	Output Capacitance		6	pF

Thermal Resistance

Tested initially and after any design or process change that may affect these parameters.

Parameter	Description	Test Conditions	165 FBGA Package	Unit
Θ_{JA}	Thermal Resistance (Junction to Ambient)	Test conditions follow standard test methods and procedures for measuring thermal impedance, in accordance with EIA/JESD51.	16.2	°C/W
Θ_{JC}	Thermal Resistance (Junction to Case)		2.3	°C/W

AC Test Loads and Waveforms



Note

19. Unless otherwise noted, test conditions are based on signal transition time of 2V/ns, timing reference levels of 0.75V, Vref = 0.75V, RQ = 250Ω, V_{DDQ} = 1.5V, input pulse levels of 0.25V to 1.25V, and output loading of the specified I_{OL}/I_{OH} and load capacitance shown in (a) of AC Test Loads and Waveforms.

Switching Characteristics

Over the Operating Range [19, 20]

Cypress Parameter	Consortium Parameter	Description	300 MHz		278 MHz		250 MHz		200 MHz		167 MHz		Unit
			Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
t_{POWER}		V_{DD}(Typical) to the First Access [21]	1		1		1		1		1		ms
t_{CYC}	t_{KHKH}	K Clock and C Clock Cycle Time	3.3	8.4	3.6	8.4	4.0	8.4	5.0	8.4	6.0	8.4	ns
t_{KH}	t_{KHKL}	Input Clock (K/$\overline{K}$; C/$\overline{C}$) HIGH	1.32	–	1.4	–	1.6	–	2.0	–	2.4	–	ns
t_{KL}	t_{KLKH}	Input Clock (K/$\overline{K}$; C/$\overline{C}$) LOW	1.32	–	1.4	–	1.6	–	2.0	–	2.4	–	ns
$t_{KH\overline{K}H}$	$t_{KH\overline{K}H}$	K Clock Rise to $\overline{K}$ Clock Rise and C to $\overline{C}$ Rise (rising edge to rising edge)	1.49	–	1.6	–	1.8	–	2.2	–	2.7	–	ns
t_{KHCH}	t_{KHCH}	K/$\overline{K}$ Clock Rise to C/$\overline{C}$ Clock Rise (rising edge to rising edge)	0	1.45	0	1.55	0	1.8	0	2.2	0	2.7	ns
Setup Times													
t_{SA}	t_{AVKH}	Address Setup to K Clock Rise	0.4	–	0.4	–	0.5	–	0.6	–	0.7	–	ns
t_{SC}	t_{IVKH}	Control Setup to K Clock Rise ($\overline{LD}$, R/$\overline{W}$)	0.4	–	0.4	–	0.5	–	0.6	–	0.7	–	ns
t_{SCDDR}	t_{IVKH}	Double Data Rate Control Setup to Clock (K/$\overline{K}$) Rise ($\overline{BWS_0}$, $\overline{BWS_1}$, $\overline{BWS_2}$, $\overline{BWS_3}$)	0.3	–	0.3	–	0.35	–	0.4	–	0.5	–	ns
t_{SD} [22]	t_{DVKH}	$D_{[X:0]}$ Setup to Clock (K/$\overline{K}$) Rise	0.3	–	0.3	–	0.35	–	0.4	–	0.5	–	ns
Hold Times													
t_{HA}	t_{KHAX}	Address Hold after K Clock Rise	0.4	–	0.4	–	0.5	–	0.6	–	0.7	–	ns
t_{HC}	t_{KHIX}	Control Hold after K Clock Rise ($\overline{LD}$, R/$\overline{W}$)	0.4	–	0.4	–	0.5	–	0.6	–	0.7	–	ns
t_{HCDDR}	t_{KHIX}	Double Data Rate Control Hold after Clock (K/$\overline{K}$) Rise ($\overline{BWS_0}$, $\overline{BWS_1}$, $\overline{BWS_2}$, $\overline{BWS_3}$)	0.3	–	0.3	–	0.35	–	0.4	–	0.5	–	ns
t_{HD}	t_{KHDX}	$D_{[X:0]}$ Hold after Clock (K/$\overline{K}$) Rise	0.3	–	0.3	–	0.35	–	0.4	–	0.5	–	ns

Notes

20. When a part with a maximum frequency above 167 MHz is operating at a lower clock frequency, it requires the input timings of the frequency range in which it is being operated and outputs data with the output timings of that frequency range.
21. This part has a voltage regulator internally; t_{POWER} is the time that the power must be supplied above V_{DD} minimum initially before a read or write operation can be initiated.
22. For D2 data signal on CY7C1529AV18 device, t_{SD} is 0.5 ns for 200 MHz, 250 MHz, 278 MHz and 300 MHz frequencies.

[+] Feedback

Switching Characteristics (continued)

Over the Operating Range [19, 20]

Cypress Parameter	Consortium Parameter	Description	300 MHz		278 MHz		250 MHz		200 MHz		167 MHz		Unit
			Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
Output Times													
t_{CO}	t_{CHQV}	C/$\overline{C}$ Clock Rise (or K/$\overline{K}$ in single clock mode) to Data Valid	–	0.45	–	0.45	–	0.45	–	0.45	–	0.50	ns
t_{DOH}	t_{CHQX}	Data Output Hold after Output C/$\overline{C}$ Clock Rise (Active to Active)	–0.45	–	–0.45	–	–0.45	–	–0.45	–	–0.50	–	ns
t_{CCQO}	t_{CHCQV}	C/$\overline{C}$ Clock Rise to Echo Clock Valid	–	0.45	–	0.45	–	0.45	–	0.45	–	0.50	ns
t_{CQOH}	t_{CHCQX}	Echo Clock Hold after C/$\overline{C}$ Clock Rise	–0.45	–	–0.45	–	–0.45	–	–0.45	–	–0.50	–	ns
t_{CQD}	t_{CQHQV}	Echo Clock High to Data Valid		0.27		0.27		0.30		0.35		0.40	ns
t_{CQDOH}	t_{CQHQX}	Echo Clock High to Data Invalid	–0.27	–	–0.27	–	–0.30	–	–0.35	–	–0.40	–	ns
t_{CQH}	t_{CQHCQL}	Output Clock (CQ/$\overline{CQ}$) HIGH [23]	1.24	–	1.35	–	1.55	–	1.95	–	2.45	–	ns
$t_{CQH\overline{CQ}H}$	$t_{CQH\overline{CQ}H}$	CQ Clock Rise to $\overline{CQ}$ Clock Rise (rising edge to rising edge) [23]	1.24	–	1.35	–	1.55	–	1.95	–	2.45	–	ns
t_{CHZ}	t_{CHQZ}	Clock (C/$\overline{C}$) Rise to High-Z (Active to High-Z) [24, 25]	–	0.45	–	0.45	–	0.45	–	0.45	–	0.50	ns
t_{CLZ}	t_{CHQX1}	Clock (C/$\overline{C}$) Rise to Low-Z [24, 25]	–0.45	–	–0.45	–	–0.45	–	–0.45	–	–0.50	–	ns
DLL Timing													
$t_{KC\ Var}$	$t_{KC\ Var}$	Clock Phase Jitter	–	0.20	–	0.20	–	0.20	–	0.20	–	0.20	ns
$t_{KC\ lock}$	$t_{KC\ lock}$	DLL Lock Time (K, C)	1024	–	1024	–	1024	–	1024	–	1024	–	Cycles
$t_{KC\ Reset}$	$t_{KC\ Reset}$	K Static to DLL Reset	30		30		30		30		30		ns

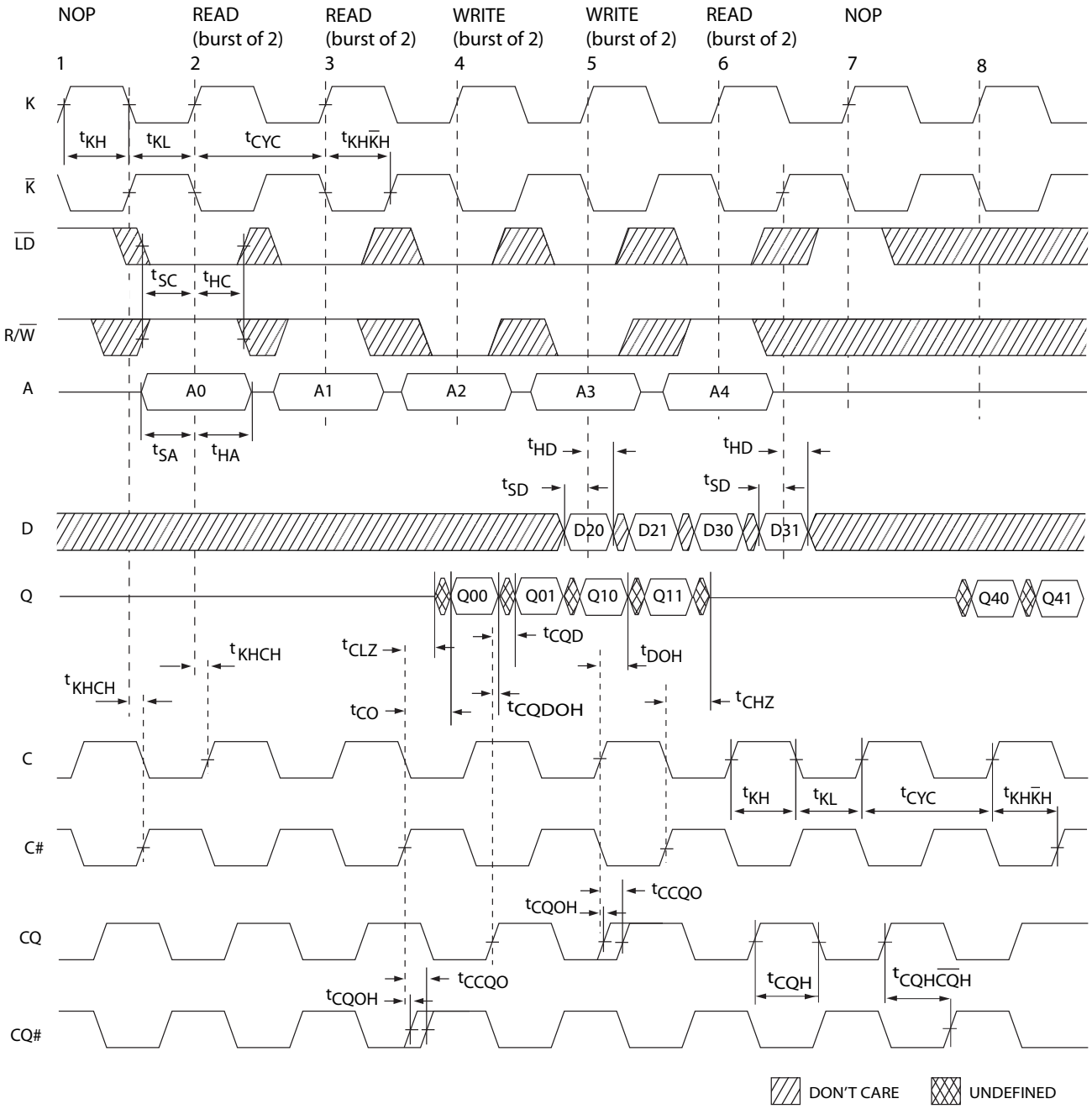
Notes

23. These parameters are extrapolated from the input timing parameters ($t_{KH\overline{K}H}$ - 250 ps, where 250 ps is the internal jitter. An input jitter of 200 ps ($t_{KC\ Var}$) is already included in the $t_{KH\overline{K}H}$). These parameters are only guaranteed by design and are not tested in production
24. t_{CHZ}, t_{CLZ}, are specified with a load capacitance of 5 pF as in (b) of AC Test Loads and Waveforms. Transition is measured ± 100 mV from steady-state voltage.
25. At any voltage and temperature t_{CHZ} is less than t_{CLZ} and t_{CHZ} less than t_{CO}.

[+] Feedback

Switching Waveforms

Figure 3. Read/Write/Deselect Sequence [26, 27, 28]



Notes
26. Q00 refers to output from address A0. Q01 refers to output from the next internal burst address following A0, that is, A0+1.
27. Outputs are disabled (High-Z) one clock cycle after a NOP.
28. In this example, if address A4 = A3, then data Q40 = D30 and Q41 = D31. Write data is forwarded immediately as read results. This note applies to the whole diagram.

[+] Feedback

Ordering Information

Not all of the speed, package and temperature ranges are available. Please contact your local sales representative or visit www.cypress.com for actual products offered.

Speed (MHz)	Ordering Code	Package Diagram	Package Type	Operating Range
300	CY7C1522AV18-300BZC	51-85195	165-Ball Fine Pitch Ball Grid Array (15 x 17 x 1.4 mm)	Commercial
	CY7C1529AV18-300BZC			
	CY7C1523AV18-300BZC			
	CY7C1524AV18-300BZC			
	CY7C1522AV18-300BZXC	51-85195	165-Ball Fine Pitch Ball Grid Array (15 x 17 x 1.4 mm) Pb-Free	
	CY7C1529AV18-300BZXC			
	CY7C1523AV18-300BZXC			
	CY7C1524AV18-300BZXC			
	CY7C1522AV18-300BZI	51-85195	165-Ball Fine Pitch Ball Grid Array (15 x 17 x 1.4 mm)	Industrial
	CY7C1529AV18-300BZI			
	CY7C1523AV18-300BZI			
	CY7C1524AV18-300BZI			
	CY7C1522AV18-300BZXI	51-85195	165-Ball Fine Pitch Ball Grid Array (15 x 17 x 1.4 mm) Pb-Free	
	CY7C1529AV18-300BZXI			
	CY7C1523AV18-300BZXI			
	CY7C1524AV18-300BZXI			
278	CY7C1522AV18-278BZC	51-85195	165-Ball Fine Pitch Ball Grid Array (15 x 17 x 1.4 mm)	Commercial
	CY7C1529AV18-278BZC			
	CY7C1523AV18-278BZC			
	CY7C1524AV18-278BZC			
	CY7C1522AV18-278BZXC	51-85195	165-Ball Fine Pitch Ball Grid Array (15 x 17 x 1.4 mm) Pb-Free	
	CY7C1529AV18-278BZXC			
	CY7C1523AV18-278BZXC			
	CY7C1524AV18-278BZXC			
	CY7C1522AV18-278BZI	51-85195	165-Ball Fine Pitch Ball Grid Array (15 x 17 x 1.4 mm)	Industrial
	CY7C1529AV18-278BZI			
	CY7C1523AV18-278BZI			
	CY7C1524AV18-278BZI			
	CY7C1522AV18-278BZXI	51-85195	165-Ball Fine Pitch Ball Grid Array (15 x 17 x 1.4 mm) Pb-Free	
	CY7C1529AV18-278BZXI			
	CY7C1523AV18-278BZXI			
	CY7C1524AV18-278BZXI			

Ordering Information (continued)

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Speed (MHz)	Ordering Code	Package Diagram	Package Type	Operating Range
250	CY7C1522AV18-250BZC	51-85195	165-Ball Fine Pitch Ball Grid Array (15 x 17 x 1.4 mm)	Commercial
	CY7C1529AV18-250BZC			
	CY7C1523AV18-250BZC			
	CY7C1524AV18-250BZC			
	CY7C1522AV18-250BZXC	51-85195	165-Ball Fine Pitch Ball Grid Array (15 x 17 x 1.4 mm) Pb-Free	
	CY7C1529AV18-250BZXC			
	CY7C1523AV18-250BZXC			
	CY7C1524AV18-250BZXC			
	CY7C1522AV18-250BZI	51-85195	165-Ball Fine Pitch Ball Grid Array (15 x 17 x 1.4 mm)	Industrial
	CY7C1529AV18-250BZI			
	CY7C1523AV18-250BZI			
	CY7C1524AV18-250BZI			
	CY7C1522AV18-250BZXI	51-85195	165-Ball Fine Pitch Ball Grid Array (15 x 17 x 1.4 mm) Pb-Free	
	CY7C1529AV18-250BZXI			
	CY7C1523AV18-250BZXI			
	CY7C1524AV18-250BZXI			
200	CY7C1522AV18-200BZC	51-85195	165-Ball Fine Pitch Ball Grid Array (15 x 17 x 1.4 mm)	Commercial
	CY7C1529AV18-200BZC			
	CY7C1523AV18-200BZC			
	CY7C1524AV18-200BZC			
	CY7C1522AV18-200BZXC	51-85195	165-Ball Fine Pitch Ball Grid Array (15 x 17 x 1.4 mm) Pb-Free	
	CY7C1529AV18-200BZXC			
	CY7C1523AV18-200BZXC			
	CY7C1524AV18-200BZXC			
	CY7C1522AV18-200BZI	51-85195	165-Ball Fine Pitch Ball Grid Array (15 x 17 x 1.4 mm)	Industrial
	CY7C1529AV18-200BZI			
	CY7C1523AV18-200BZI			
	CY7C1524AV18-200BZI			
	CY7C1522AV18-200BZXI	51-85195	165-Ball Fine Pitch Ball Grid Array (15 x 17 x 1.4 mm) Pb-Free	
	CY7C1529AV18-200BZXI			
	CY7C1523AV18-200BZXI			
	CY7C1524AV18-200BZXI			

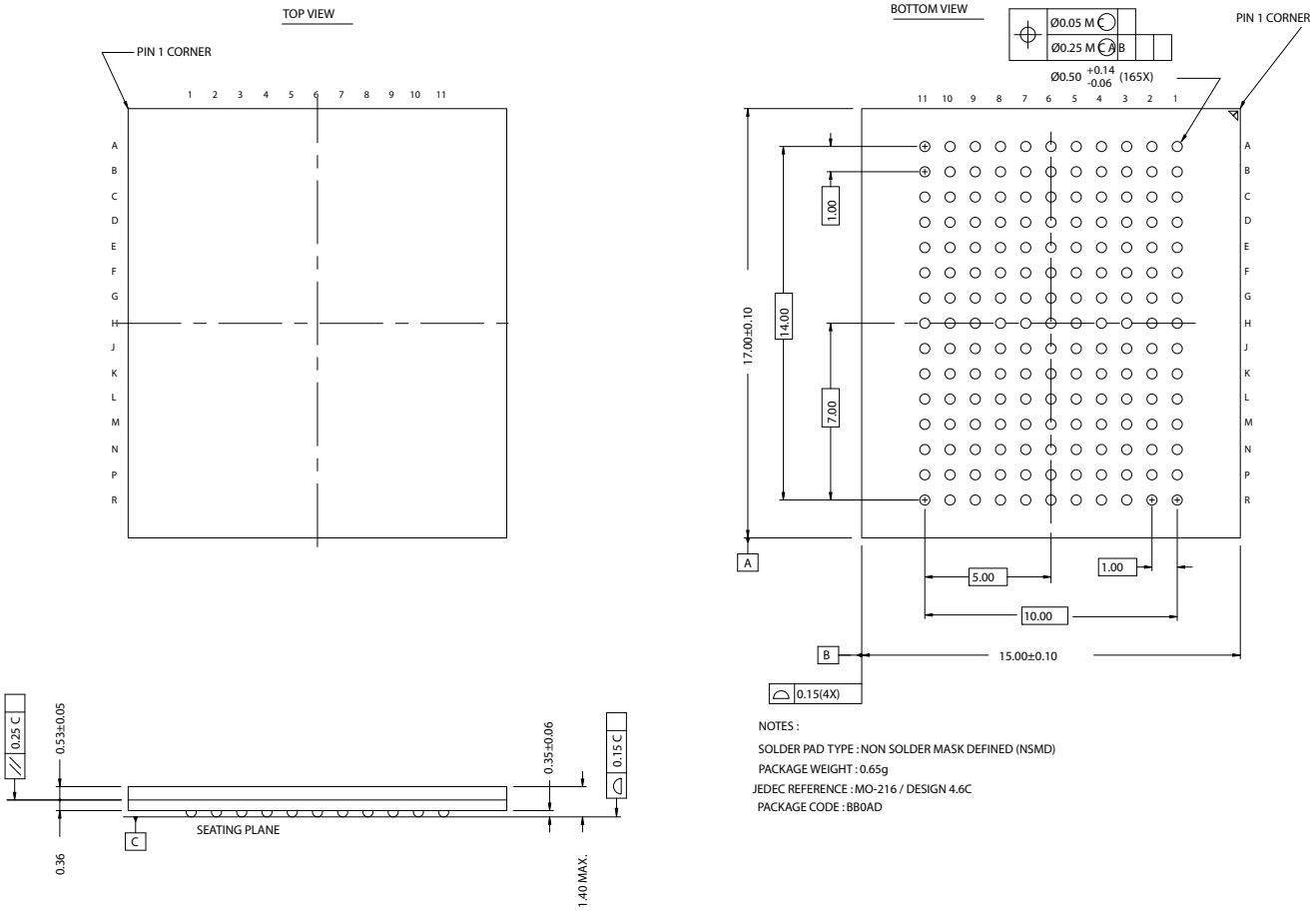
Ordering Information (continued)

Not all of the speed, package and temperature ranges are available. Please contact your local sales representative or visit www.cypress.com for actual products offered.

Speed (MHz)	Ordering Code	Package Diagram	Package Type	Operating Range
167	CY7C1522AV18-167BZC	51-85195	165-Ball Fine Pitch Ball Grid Array (15 x 17 x 1.4 mm)	Commercial
	CY7C1529AV18-167BZC			
	CY7C1523AV18-167BZC			
	CY7C1524AV18-167BZC			
	CY7C1522AV18-167BZXC	51-85195	165-Ball Fine Pitch Ball Grid Array (15 x 17 x 1.4 mm) Pb-Free	
	CY7C1529AV18-167BZXC			
	CY7C1523AV18-167BZXC			
	CY7C1524AV18-167BZXC			
	CY7C1522AV18-167BZI	51-85195	165-Ball Fine Pitch Ball Grid Array (15 x 17 x 1.4 mm)	Industrial
	CY7C1529AV18-167BZI			
	CY7C1523AV18-167BZI			
	CY7C1524AV18-167BZI			
	CY7C1522AV18-167BZXI	51-85195	165-Ball Fine Pitch Ball Grid Array (15 x 17 x 1.4 mm) Pb-Free	
	CY7C1529AV18-167BZXI			
	CY7C1523AV18-167BZXI			
	CY7C1524AV18-167BZXI			

Package Diagram

Figure 4. 165-Ball FBGA (15 x 17 x 1.4 mm), 51-85195



[+] Feedback

Document History Page

Document Title: CY7C1522AV18/CY7C1529AV18/CY7C1523AV18/CY7C1524AV18, 72-Mbit DDR-II SIO SRAM 2-Word Burst Architecture Document Number: 001-06981				
REV.	**ECN NO.**	**ISSUE DATE**	**ORIG. OF CHANGE**	**DESCRIPTION OF CHANGE**
**	433241	See ECN	NXR	New Data Sheet
*A	462002	See ECN	NXR	Changed t_{TCYC} from 100 ns to 50 ns, changed t_{TH} and t_{TL} from 40 ns to 20 ns, changed t_{TMSS}, t_{TDIS}, t_{CS}, t_{TMSH}, t_{TDIH}, t_{CH} from 10 ns to 5 ns and changed t_{TDOV} from 20 ns to 10 ns in TAP AC Switching Characteristics table Modified Power-Up waveform
*B	503690	See ECN	VKN	Minor change: Moved data sheet to web
*C	1523363	See ECN	VKN/AESA	Converted from preliminary to final Updated Logic Block diagram Updated I_{DD}/I_{SB} specs Changed DLL minimum operating frequency from 80MHz to 120MHz Changed t_{CYC} max spec to 8.4ns for all speed bins Modified footnotes 20 and 28

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